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SUBMISSION OF SUBSTITUTE SPECIFICATION

Commissioner for Patents
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Sir:

Attached are a Substitute Specification and a marked-up copy of the original specification. I certify that said substitute specification contains no new matter and includes the changes indicated in the marked-up copy of the original specification.

June 5, 2006

Respectfully submitted,

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FORMING TOOL

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] This application is a National Phase of PCT/EP2004/012690, filed November 101, 2004, and claims the priority of German patent document DE 103 56 534.5, filed December 4, 2003, the disclosure of which is expressly incorporated by reference herein.

[0002] The invention relates to a forming die of the type that has a recess which forms a shaping space into which a workpiece can be introduced.

[0003] A forming die of the generic type which is disclosed in German patent document DE 101 39 135 A1, has a vent line which is formed as a passage, runs within a die block of the forming die and connects the shaping space formed by the die cavity to the area surrounding the die. During [[the]] shaping of the workpiece, the air which is present in the shaping space is displaced from the forming die by deformation of the workpiece, so that the latter molds itself accurately to match the cavity of the shaping space. However, the vent line opens out at the cavity, the opening where it opens out forms an extremely undesirable mark on the

workpiece on account of the high contact pressure with which the workpiece is pressed onto the cavity to achieve the required contour accuracy. The opening of the line may even be so large that the workpiece is pressed into the line, where it is undesirably stamped out, which inevitably leads to the part being scrapped.

[0004] One object of the invention is to provide a forming die of the generic type, which is simple, and which, during the shaping of a workpiece, achieves contours that are unaffected by the arrangement of passages connecting the shaping space to the area surrounding the die.

[0005] This and other objects and advantages of the invention are achieved by the forming die according to the invention, in which a liquid-permeable and gas-permeable insert body is arranged in the forming die, a peripheral region of which forms a portion of the cavity. Due to a fluidic connection of the passage to this insert body, the opening where the passage opens out is covered, so that no imprint of this opening is formed on the workpiece when it is being pressed onto the cavity by the forming process, in particular in the calibration phase. Therefore, the contours of the workpiece remain unaffected during shaping.

[0006] Since the insert body is permeable to liquid and gas, the function of the passage, namely that of discharging (and if appropriate

also supplying) liquid or a gas, for example air, is completely retained. An insert body of this type is simple to produce and can readily be installed in the die after the recess intended for it has been formed. When a certain state of wear has been reached, the insert body can be exchanged with little difficulty using suitable securing means.

[0007] Moreover, the invention also obviates the problem of predetermining the correct position for forming the passage, since the insert body means that the media which are to be discharged from the cavity are captured over a certain area rather than in punctiform fashion, and can pass through the insert body virtually unimpeded until they reach the opening of the passage. As a result, accurate positioning of the passage is no longer necessary; the passage can now open out at any desired position of the insert body.

[0008] In a particularly preferred refinement of the invention, the insert body consists of a porous sintered metal, which ensures that it is able to withstand the contact pressures resulting from the deformation without being damaged. The porosity is effected by simple pores and micropassages through which liquids and gases can penetrate.

[0009] In a further preferred configuration of the invention, the insert body is an ultrafine sieve or a diaphragm. If an ultrafine sieve is used, it should be ensured that the mesh is designed to be as rigid and durable as possible, and is kept as small as possible, so that on the one hand the

contact pressures can be absorbed and on the other hand an imprint of the meshes on the workpiece is prevented. If a diaphragm is selected, the diaphragm should be rigid in order to cope with the contact pressures. Of course, the diaphragm must also be permeable to liquids and gases. In addition to complete permeability in this respect, semipermeability of the diaphragm is also conceivable. Ultrafine sieves and diaphragms are inexpensive, very simple to produce and particularly simple to apply to the die. In this case, it is also possible for existing forming dies to be retrofitted with an insert body of this type with only a very small amount of effort.

[0010] In a further particularly preferred configuration of the forming die according to the invention, the forming die is a hydroforming die, and the workpiece is formed by a peripherally continuous hollow profiled section. If the forming die is used as a hydroforming die, the configuration of the forming die in accordance with the invention is highly advantageous, since it is known that in the hydroforming process extremely high pressures are exerted on the hollow profiled section, which likewise leads to immense contact pressures of the hollow profiled section against the die cavity. As a result the shape of the cavity is highly accurately reproduced on the hollow profiled section; therefore, the way in which the invention prevents imprints of the openings of

passages connected to the shaping space is highly important. As a result, the outer contour of the hollow profiled section, which is of tolerance-free and highly accurate configuration as a result of the hydroforming process, is retained without need to dispense with the supply or removal of liquids or gases from the shaping space or into the shaping space.

[0011] Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The single figure is a lateral longitudinal section, which shows a representative embodiment of a forming die according to the invention, with insert bodies arranged at the shaping space.

DETAILED DESCRIPTION OF THE DRAWING

[0013] The figure illustrates a hydroforming die formed as forming die 1, which has a cavity 3 forming a shaping space, into which a workpiece (in this case a hollow profiled section) is introduced. (The forming die 1 may also be a deep-drawing die.) A plurality of passages 4,

5, 6 and 7, which connect the shaping space 2 to the area surrounding the die, have been machined into the forming die. The passages 4 to 7 are used to supply and/or discharge lubricant to the hollow profiled section which has been introduced into the forming die 1, in order to reduce the friction between the hollow profiled section and the cavity 3 during the forming process. The passages 4 to 7 can also be used to discharge air and pressure medium, which otherwise (on account of being enclosed in the shaping space 2) would very substantially impede the forming process. Air and pressurized fluid in the shaping space 2 originate on the one hand from the volume of air which has not been expelled during closure of the forming die 1 and on the other hand, with regard to the pressurized fluid, from two pressurized fluid fractions, namely the pressurized fluid which flows out after removal of a fully shaped hollow profiled section from the forming die 1 and the pressurized fluid which undesirably enters the gap between hollow profiled section and cavity 3, passing into the shaping space 2, during filling of the hollow profiled section.

[0014] A plurality of liquid and gas-permeable insert bodies 8 are integrated in the forming die 1 and are each accommodated in a recess 9 in the die 1 near to the shaping space. Although the insert bodies 8 in this case consist of a porous sintered metal, it is also possible for them to

be formed by an ultrafine sieve or a diaphragm. The peripheral or surface region 10 of the insert bodies 8 which faces the shaping space 2 itself in each case forms a portion of the cavity 3, so that there are no discontinuities in the profile of the cavity 3. The passages 4 to 7 which run within the forming die 1 open out at a rear side 11 of the respective insert body 8 outside said peripheral region 10.

[0015] On account of the porosity of the insert body 8, the air or pressurized fluid can penetrate through the pores and/or micropassages of the insert body 8 into the passages 4 to 7, from which they are discharged from the forming die either through the force of gravity or by means of a suitable pump. Therefore, air and pressurized fluid can easily be displaced by the workpiece, which is moving ever closer to the cavity 3, out of the shaping space 2 into the passages 4 to 7 via the insert bodies 8, without an imprint of the opening of the passages 4 to 7 being formed after the workpiece comes into contact with the cavity 3.

[0016] Furthermore, it is also conceivable to use an insert body 8 which includes relatively large parts of the die cavity 3 and in this case comprises a plurality of regions of the cavity 3 which are prone to inclusions of media and therefore require discharge of air and pressurized fluid. It is sufficient in this case for only a single passage to be connected to this elongate insert body 8, since on account of the displacement pressure originating from the workpiece which is being shaped, the air and the pressurized fluid can also penetrate through lateral, oblique

and/or labyrinth-like micropassages and pores in the insert body 8 in order to enter the passage 4, 5, 6 or 7. As a result, there is no need for accurate positioning of the passage 4, 5, 6 or 7, which leads to considerable simplification of the design of the die 1, and the production of the passage can be automated during manufacture of the die 1. It is in this case possible to select a location which is the most appropriate both for the discharge of the media and for the design of the die.

[0017] Furthermore, it is also possible for the hydroforming die 1 to be configured for the widening of plates, in which case the workpiece is formed by two plates on top of one another, which are clamped in the forming die 1 between its upper and lower die blocks. A fluidic internal high pressure is generated between the plates by means of a lance-like plunger which is assigned to the forming die 1, has at least one axial pressurized fluid passage inside it and is inserted between the plates, with the result that these plates are expanded to form a hollow profiled section.

[0018] The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.